CBD SOT CONFERENCE TODAY'S INNOVATION, TOMORROW'S WARFIGHTER CAPABILITIES

Field-Forward Diagnostics

Integrated Solution for Point-of-Need Detection of Pathogens

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Our overarching goal is to develop a rapid and high-throughput diagnostic capability to measure the copy number of pathogens in clinically relevant samples (i.e., saliva and blood). Currently, clinical diagnostic approaches that identify pathogens emphasize: i) nucleic acid amplification approaches (e.g., qRT-PCR) and ii) protein antigen capture immunoassays.

Nucleic acid amplification is typically not reliable due to: i) inhibitors in complex biological samples (e.g., whole blood or saliva) that interfere with target RNA isolation or result in the differential amplification efficiency of the target RNA relative to the test standards and ii) assay complexity that requires trained scientists in a sophisticated laboratory setting. Likewise, immunoassays have limited reliability due to cross-reactivity between similar antigens on different pathogens or sensitivities to antigen conformation that limit antibody recognition.

Overcoming these barriers to create point-of-need diagnostic capabilities required us to develop stable reagents that enable affinity isolation and direct readouts of unique pathogen markers through a hand-held mobile device that permits centralized data collection and analysis. Reagents are fluorescent derivatives of: i) phosphorodiamidate morpholino oligonucleotide (PMO) probe pairs and ii) stabilized scFv antibodies that respectively bind to proximal sites on the target DNA/RNA or protein antigen to create a unique signature. Covalent incorporation of these reagents into hydrogel materials allow their functional stabilization and multiplexing, thereby facilitating the direct and selective detection of pathogens in a format that permits high-throughput data collection. These engineered hydrogel materials maintain their detection capability following long-term storage, enabling point-of-need detection following hydration.

Reliable measurements are possible due to the unique properties of PMO probes which, unlike other nucleotide probes, retain high-affinity binding to DNA/RNA targets under conditions of low ionic strength or in the presence of chaotropic agents. Likewise, newly developed hydrogel materials stabilize scFv antibodies under conditions that denature pathogenic protein markers (i.e., 8 M urea), enabling reliable detection of linear peptide epitopes. Advantages of these assay conditions include rapid inactivation of pathogens, enabling a low risk collection and subsequent analysis at point of contact.

Hardware and software capabilities are built onto a rugged mobile platform using the ultralight (13.5 oz) Trimble Juno T41XG handheld computer (environmentally rated at IP68). This device contains a GPS receiver (< 2 meter accuracy), Android embedded 6.5 512 MB RAM, 32 GB storage, 8 megapixel camera, and penta-band GSM cellular phone and data capacity that includes barcode scanning to capture metadata from engineered mobile photodectors. Mobile handheld instruments are self-contained (running off easily recharged battery power) to enable point-of-need diagnostics.

Together, these reagents, hardware, and integrated software capabilities create point-of-need diagnostic capabilities able to integrate environmental exposures for warfighters in the field and enable integration of data to track geographical distributions of individual pathogens that can contribute to operational safety.

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